



INSTITUTE FOR DEFENSE ANALYSES

**Evidence on the Effect of DoD Acquisition
Policy and Process and Funding Climate
on Cancellations of Major Defense
Acquisitions Programs**

David L. McNicol
Sarah K. Burns
Linda Wu

May 2015

Approved for public release;
distribution is unlimited.

IDA Paper P-5218

Log: H 14-001307



The Institute for Defense Analyses is a non-profit corporation that operates three federally funded research and development centers to provide objective analyses of national security issues, particularly those requiring scientific and technical expertise, and conduct related research on other national challenges.

About This Publication

This work was conducted by the Institute for Defense Analyses (IDA) under contract HQ0034-14-D-0001, Project AY-7-357816, "Root Cause Analysis and Performance Assessment Methods and Analyses (Cost Growth 14)," for the Director, Performance Assessments and Root Cause Analyses. The views, opinions, and findings should not be construed as representing the official position of either the Department of Defense or the sponsoring organization.

Acknowledgments

Thank you to Daniel L. Cuda, David A. Sparrow, and David M. Tate for performing technical review of this document.

Copyright Notice

© 2014, 2015 Institute for Defense Analyses
4850 Mark Center Drive, Alexandria, Virginia 22311-1882 • (703) 845-2000.

This material may be reproduced by or for the U.S. Government pursuant to the copyright license under the clause at DFARS 252.227-7013 (a)(16) [Jun 2013].

INSTITUTE FOR DEFENSE ANALYSES

IDA Paper P-5218

**Evidence on the Effect of DoD Acquisition
Policy and Process and Funding Climate
on Cancellations of Major Defense
Acquisitions Programs**

David L. McNicol
Sarah K. Burns
Linda Wu

Executive Summary

This paper is motivated by a 2014 Institute for Defense Analyses (DA) paper¹ (hereafter McN-W (2014)) on whether there is a statistically significant association between cost growth and changes over time in acquisition policies and processes, after taking funding climate into account. McN-W (2014) found that there is not a statistically significant association between cost growth and the changes in acquisition policy and process. There was, however, a statistically significant association between cost growth and funding climate. In particular, average cost growth was much higher for Major Defense Acquisition Programs (MDAPs) that entered what is now called System Design and Development (SDD) in “bust” phases of the “boom-bust” cycles in Department of Defense (DoD) funding.

McN-W (2014) used cost growth data only for MDAPs that completed development and went into production. This paper extends the analysis to MDAPs that were cancelled. The program outcome metric used, however, is cancellations, not cost growth.

The paper begins with a brief survey of MDAP cancellations, which is not available in the literature. The next section asks whether very high cost growth is the main cause of most cancellations. These two “scene setters” open the door to a deeper look at the data. They are followed by a section that states the plan of the analysis and then the two main analytical sections and conclusions.

A Brief Census of Cancellations

The population used in this paper was the set of 278 MDAPs that passed Milestone (MS) B or, prior to 2000, MS II during 1970–2007. Of these, fifty-three—just under 20 percent of the total—were cancelled. Cancellation rates were roughly comparable across the Services, although joint programs were somewhat more likely to be cancelled. Forty-three percent of the cancellations were initiated by the Office of the Secretary of Defense and 34 percent by the Services. The remaining cancellations were initiated by the White House or the Congress. The median time from MS II/B to cancellation was 4.3 years and the average time, 5.2 years. Only eight of the programs cancelled were in Low Rate Initial Production, and only one was in Full Rate Production.

¹ David L. McNicol and Linda Wu, “Evidence on the Effect of DoD Acquisition Policy and Process on Cost Growth of Major Defense Acquisition Programs,” IDA Paper P-5126, Alexandria, VA: Institute for Defense Analyses, September 2014.

Cost Growth and Cancellations

It seems to be the conventional wisdom that cost growth is a major cause of most program cancellations. There are some well-known instances in which this was the case. The literature, however, does not establish that it is a typical cause of program cancellations. That is a point that needs to be checked and at least to some extent can be.

We were able to estimate cost growth for twenty-five of the fifty-three MDAPs that were cancelled. The database used for McN-W (2014) provides cost growth estimates for an additional 151 MDAPs that were not cancelled, for a total of 176 programs. Fifty of these 176 programs showed growth of at least 50 percent. Of these, ten were cancelled and forty were not. The sample cancellation rate for programs with cost growth of at least 50 percent is then 20 percent. The cancellation rate for programs with cost growth of less than 50 percent is much less—about 12 percent. The key point for present purposes, however, is that 80 percent of the MDAPs with cost growth estimates of at least 50 percent were not cancelled. In short, there is more than cost growth influencing MDAP cancellations.

Plan of the Analysis

The question asked is whether the different acquisition regimes and funding climates have a statistically discernible association with cancellation rates. Each of two cancellation rates was considered:

- The cancellation rate for the cohort of MDAPs that passed MS II/B during a period of years. For example, 45 MDAPs passed MS II during Fiscal Year (FY) 1994–FY 2000, of which 6 were eventually cancelled, for a cohort cancellation rate of 13 percent.
- The average number of cancellations over a span of years. For example, in the four years FY 1986–FY 1989, nine MDAPs were cancelled, for an average cancellation rate of 2.3/yr.

This paper distinguishes five successive DoD acquisition regimes:

1. Defense Systems Acquisition Review Council (DSARC), 1970–1982
2. Post-Carlucci Initiatives DSARC, 1983–1989
3. Defense Acquisition Board (DAB), 1990–1993
4. Acquisition Reform (AR), 1994–2000
5. DAB post AR, 2001–2012

There were two complete bust-boom cycles during the period 1970–2008:

- The reduction in DoD funding associated with the winding down of US involvement in the War in Vietnam through the end of the Carter-Reagan buildup, roughly 1970–1986.
- The post-Cold War reduction in DoD funding and the subsequent buildup associated with the wars in Afghanistan and Iraq, roughly 1987–2008.

The start of the withdrawal of US forces from Iraq in 2009 marked the start of a third cycle, which was ratified by passage of the Budget Control Act (BCA) in 2011.

Changes over time in acquisition regime and the boom-bust cycle in DoD funding provide natural experiments that may shed some light on the effects of acquisition policy and funding climate on cancellation rates. For example, looking at changes in the cohort cancellation rate across successive acquisition regimes during bust phases may reveal the effects of changes in acquisition regime. While such analyses can be useful, it is necessary to recognize that, in addition to the easily identified elements of the natural experiment, there are other factors that may have influenced cohort cancellation rates. We first state the statistical results for the basic natural experiments and then ask whether they are compromised by the omission of other factors.

Analysis of Cohort Cancellation Rates

Both bust and boom conditions were experienced during three of the acquisition regimes. For two of these, the statistical analysis indicated that the average cancellation rates of cohorts that passed MS II/B in bust periods were not significantly different from those of cohorts that passed MS II/B in boom periods. The difference was significant, however, for the Post-Carlucci DSARC, which had a very high average cancellation rate for the cohort that passed MS II in the bust years FY 1987–FY 1989 (42 percent) and a comparatively low cancellation rate for the cohort of FY 1983–FY 1986 (12 percent). The average cohort cancellation rate under the Post-Carlucci DSARC also was significantly higher than those of the other acquisition regimes in the bust phase of the cycle. Two factors not considered in the statistical analysis may have influenced the results:

- The end of the Cold War; and
- An apparent reduced emphasis during the second Reagan Administration on the policy of not starting more MDAPs than likely future budgets could sustain.

The conclusion reached depends on the weight given to these historical considerations. If they are discounted, the conclusion would be that during the Post-Carlucci DSARC regime, the effect of funding climate on the average cohort cancellation rate was statistically significant and significantly higher for this regime than for other acquisition

regimes. If, instead, the historical factors are heavily weighted, the conclusion would be that neither acquisition regime nor funding climate mattered for cohort cancellation rates. The difference between these two positions is thin. A reasonable summary conclusion is that neither acquisition policy and process changes nor changes in funding climate have had much, if any, effect on average cohort cancellation rates.

Analysis of Annual Cancellation Rates

We found that the budget climates relevant to analysis of annual cancellation rates were (1) years in which the funds appropriated for DoD were increasing or stable; and (2) periods in which DoD funding decreased significantly from one year to the next. The average annual cancellation rates for this partitioning of funding climates appear in the table below. Note that the average annual cancellation rates are comparatively high in periods when DoD funding was sharply declining and comparatively low in periods in which funding was stable or increasing.

Average Number of Cancellations per Fiscal Year by Acquisition Regime and Funding Climate

| Acquisition Regime | Sharply Decreasing Funding | | Stable or Increasing Funding | |
|---------------------|----------------------------|---------------------------|------------------------------|---------------------------|
| | Period | Cancellation Rate | Period | Cancellation Rate |
| DSARC | | | 1970–1982 | 0.5/yr. (6 in 13 yrs.) |
| Post-Carlucci DSARC | 1986–1989 | 2.3/yr. (9 in 4 yrs.) | 1983–1985 | 0.3/yr. (1 in 3 yrs.) |
| DAB | 1990–1993 | 3.3/yr. (13 in 4 yrs.) | | |
| AR | | | 1994–2000 | 0.4/yr. (3 in 7 yrs.) |
| DAB post AR | 2009–2012 | 2.8/yr. (11 in 4 yrs.) | 2001–2008 | 1.3/yr. (10 in 8 yrs.) |

Note: Number of cancellations in parentheses.

We found no statistically significant association between acquisition regime and average annual cancellation rates. The average annual cancellation rate, however, is significantly higher in periods when acquisition funding is declining than it is in periods of stable or increasing funding. Loosely stated, the conclusions are that cancellations tend to cluster in periods when the DoD budget is falling, and changes in acquisition policy and process made over the years have not influenced average annual cancellation rates.

Conclusions

The conclusions offered here include both generalities and exceptions to the generalities, and these may be equally important.

Average cohort cancellation rates are not strongly influenced by either acquisition regime or funding climate. The exceptions to this rule are provided by the Post-Carlucci DSARC, which had a:

- Significantly higher cohort cancellation rate than the other acquisition regimes in the bust period FY 1987–FY 1989; and
- Significantly higher average cohort cancellation rate in the bust period than in the boom period.

This exception deserves further exploration as it may provide an excellent illustration of a mechanism that could help limit the number of new starts to what likely future budgets will support.

In contrast, annual cancellation rates, although not strongly influenced by acquisition regime, are strongly associated with funding climate. A possible exception to the first part of this rule is provided by the DAB post AR, which had a significantly higher average annual cancellation rate than other acquisition regimes during periods of Stable or Increasing funding. There were no exceptions to the second part of the rule. The complications and uncertainties involved with the conclusions on the effects of changes in acquisition regimes should not be allowed to obscure this point. Sharp cuts in DoD funding are associated with high annual cancellation rates: about 60 percent of all cancellations took place in two periods of large cuts in acquisition funding.

The conclusions offered by this paper primarily are useful because they direct attention to considerations whose centrality has not been recognized in discussions of acquisition reform. Attention typically has focused on acquisition policy and process. While changes in acquisition policy and process are quite possibly justified on other grounds, the many that have been made in the past seem to have influenced cancellations at most episodically. In contrast, changes in funding climate are strongly associated with cancellations. They arguably have been crucial. DoD force structure, the capabilities that the Department was expected to provide, and funding were inconsistent during the 1970s and for more than a decade after the end of the Cold War. That inconsistency, rather than flaws in acquisition policy or process, is the context in which most cancellations arise and is presumably a major factor to be considered in designing proposals for improved outcomes.

Contents

| | | |
|----|--|-----|
| A. | Introduction | 1 |
| B. | A Brief Census of Cancellations and Truncations | 2 |
| 1. | Definitions, Criteria, and Issues in their Application | 2 |
| 2. | Cancellations | 4 |
| 3. | Truncations | 7 |
| C. | Cost Growth and Cancellations | 9 |
| D. | Plan of the Analysis | 11 |
| E. | Analysis of Cohort Cancellation Rates | 12 |
| 1. | Statistical Analysis | 13 |
| 2. | Discussion | 14 |
| F. | Analysis of Annual Cancellation Rates | 17 |
| 1. | Statistical Analysis | 17 |
| 2. | Discussion | 19 |
| G. | Conclusions | 22 |
| | Illustrations | A-1 |
| | References | B-1 |
| | Abbreviations | C-1 |

Supporting data files provided on CD (inside back cover):

- 1-Database 31Mar15.xlsx
- 2-Selected MDAP Cancellations_1970-2012.xlsx
- 3-Cancelled MDAPs PAUC Growth.xlsx
- 4-Notes on Programs Examined.docx

A. Introduction

This paper is motivated by a 2014 Institute for Defense Analyses (IDA) paper¹ (hereafter McN-W (2014)) on whether there is a statistically significant association between cost growth and changes over time in acquisition policies and processes, after taking into account funding climate. McN-W (2014) found that there is not a statistically significant association between cost growth and the changes in acquisition policy and process that had occurred. There was, however, a statistically significant association between cost growth and funding climate. In particular, average cost growth was much higher for Major Defense Acquisition Programs (MDAPs) that entered what is now called System Design and Development (SDD)² during “bust” phases of the “boom-bust” cycles in Department of Defense (DoD) funding.

McN-W (2014) used cost growth data only for programs that had successfully completed development and gone into production. This paper is an extension of McN-W (2014) to MDAPs that were cancelled. The program outcome metric used, however, is cancellations, not cost growth.

The next two sections function as scene setters. Section B offers a brief survey of cancellations and truncations of MDAPs, which is not available in the literature. Section C asks whether very high cost growth is the main cause of most cancellations. For the subset of programs examined, it appears that it is not, which opens the door to a deeper look at the data.

Section D describes the plan of the analysis, which is built around two different measures of the cancellations:

- The cancellation rate for the cohort of MDAPs that passed Milestone (MS) II/B³ during a period of years. For example, during Fiscal Year (FY) 2001–FY 2002, 15 MDAPs passed MS B, of which four were eventually cancelled, for a cohort cancellation rate of 27 percent. During FY 1990–FY 1993, 16 programs passed MS B, of which only one was eventually cancelled, for an average cohort cancellation rate of 6 percent.

¹ David L. McNicol and Linda Wu, “Evidence on the Effect of DoD Acquisition Policy and Process on Cost Growth of Major Defense Acquisition Programs,” IDA Paper P-5126, Alexandria, VA: Institute for Defense Analyses, September 2014.

² SDD was called Full Scale Development into the late 1980s and then Engineering and Manufacturing Development.

³ DoDI 5000.2, issued October 23, 2000, formally established MSs A, B, and C (in place of MSs I, II, and III) as the main decision points for an MDAP. The definitions are such that MS B is placed several months earlier in the process than MS II.

- The average number of cancellations over a span of years. For example, during the four-year period FY 1986–FY 1989, nine MDAPs were cancelled, for an average cancellation rate of 2.3/yr. Two MDAPs were cancelled during the five years FY 1994–FY 1998, for an average cancellation rate of 0.4/yr.

Cohort and annual cancellation rates are examined in Sections E and F, respectively. In each of these sections, the question asked is whether the acquisition policies and processes in effect at the time and the funding climate have a statistically discernible association with cancellation rates. Are cancellation rates particularly low for MDAPs that passed MS II/B in certain acquisition regimes? Do programs that pass MS II/B when funding is especially tight have a significantly higher (or lower) cancellation rate?

B. A Brief Census of Cancellations and Truncations

This paper's database took as its point of departure that of McN-W (2014). Their database was intended to be comprised of all MDAPs that passed MS II/B during the years 1970–2007.⁴ It included 309 programs. Of these, sixty-one had been identified as cancelled, thirteen as truncated, and three as reorganized, for a total of seventy-seven programs. We also considered a RAND study from 1996 that identified forty-three cancelled programs.⁵ Of these, thirty-two were also on our list of cancelled programs; there were eleven programs on RAND's list not on ours, and we had identified eleven programs as cancelled that were not on RAND's list. As a result, our list of suspected cancellations increased to ninety-nine. We reviewed each of these ninety-nine programs to verify that it was correctly classified and to extract additional data from the Selected Acquisition Reports (SARs) for the cancelled programs. The compact disc (CD) in the pocket on the inside back cover of this paper provides brief notes on ninety-two of these programs that were problematical in one way or another.

1. Definitions, Criteria, and Issues in their Application

With few exceptions the differences between the IDA and RAND lists of cancelled programs reflected the use of different business rules. Reconciling our list of cancelled programs with RAND's, therefore, required an explicit criterion for cancellation and

⁴ The database includes programs that passed MS II/B at the Service level and subsequently filed at least one SAR. Not all of these were Acquisition Category (ACAT) I programs. The database also includes a small number of programs that entered at MS III/C or with MS II/B authority and authorization to proceed to Low Rate Initial Production (LRIP) without an additional authorization from the Milestone Decision Authority (MDA).

⁵ Jeanne M. Jarvaise, Jeffrey A. Drezner, and Dan Norton, "The Defense System Cost Performance Database: Cost Growth Using Selected Acquisition Reports," RAND Report MR-625-OSD (Santa Monica, CA: The RAND Corporation, 1996), Appendix B. The most recent SARs used in the RAND study were those for December 1994.

criteria for decisions on what programs should be in the population. We decided to classify a program as cancelled if:

- The program did not result in production of any fully configured end items, or
- Any fully configured end items produced were used only for testing and development.

The criteria adopted for inclusion in the population of programs were dictated by the purpose of the analysis, which is to gauge the effect of different Office of the Secretary of Defense (OSD)-level acquisition regimes and funding climates on cancellations. Our population then should include only programs subject to OSD-level acquisition policy and process. Even if a program files one or more SARs, OSD oversight pre-MS II/B generally is less rigorous than it is post-MS II/B, and ACAT II, III, and IV programs generally are not subject to OSD-level oversight. Finally, once a program loses ACAT I status, it typically reverts to Service-level oversight and cannot be tracked with the data sources available for this paper. Accordingly, we exclude programs cancelled

- before they passed MS II/B;
- before they were designated as an ACAT I program; or
- after they were removed from ACAT I status because they no longer met the relevant criteria.

A program that met any of these three conditions was not only excluded from the list of cancelled programs but from the population. Programs that entered SDD before the establishment of the Defense Systems Acquisition Review Council (DSARC) in 1969 also were excluded from the population, as were Special Access programs. Finally, the population did not include any programs that passed MS B after FY 2007.⁶ These exclusions reduced the number of programs included in the main database from 309 to 278.⁷ The main database is the first Excel file on the included CD.

Application of these criteria was not entirely cut and dried for three sets of programs. First, we identified six programs that passed MS II/B at the Service level, later filed SARs, and subsequently were cancelled. We retained on the list of cancelled programs the five that had been formally designated as an ACAT I program and excluded

⁶ In order to allow a reasonable period for cost growth to appear, the McN-W (2014) database included only programs that were at least five years into SDD. The December 2012 SARs were the most recent available when that database was compiled, so the last cohort included in the population was the one that passed MS B in FY 2007. The database for the present paper includes cancellations of those programs through the end of FY 2012.

⁷ The A-6E and the A-6F were reported on the same SAR. The A-6E was a successful program, while the A-6F was cancelled. For that reason, the A-6E and the A-6F are entered separately on the list of programs.

the one that had not.⁸ Second, there is a question as to whether three systems from about 1969 actually passed a formal MS II review. These are the B-1A Lancer, the XM800 Armored Reconnaissance Vehicle (SCOUT), and the XM803 Main Battle Tank. The DSARC had been established a very short time when these programs entered SDD. There was evidence of OSD involvement in the launch of these programs, however, and on that basis they were included in the population and on the list of cancelled programs. Finally, as noted above, the population includes a small number of programs that entered at MS III/C or with MS II/B authority and authorization to proceed to LRIP without an additional authorization from the MDA.

We classified as cancelled fifty-two of the MDAPs in the population using the criteria stated above. The C-27J also was included on the list of cancelled programs, for a total of fifty-three, because the twenty-one C-27Js produced were placed directly in long-term storage. The second Excel file on the included CD lists these programs and provides some information on each of them.

We identified sixteen additional programs that filed one or more SARs during FY 1970–FY 2007 and were cancelled. These programs are listed in the “Notes on Programs Examined” file provided on the CD included with this paper; they appear as numbers 54-69. These sixteen were not included on the list of cancelled programs because they were either cancelled before passing MS II/B, were never designated an ACAT I program, or were cancelled after they fell below the ACAT I level.

2. Cancellations

Just under one in five of the 278 MDAPs of our population had been cancelled by the end of FY 2012 (see Table 1). Consistent with the conventional wisdom, the cancellation rate for joint programs (27 percent) is somewhat higher than the average for Service-managed programs (about 18 percent). The Department of the Navy has the lowest cancellation rate (15 percent) and the Army the highest (20 percent). The differences are not large, however. Had the Navy cancelled two more programs (over the course of 43 years), the Army two less, and the Air Force one less, the Services would have had virtually the same cancellation rates.

⁸ An/WQR-Advanced Deployable System, AQM-127A Supersonic Low Altitude Target, Advanced Seal Delivery System, ASM-135A Air-Launched Anti-Satellite System, and Land Warrior. Extended Range Munition was cancelled before it was designated an ACAT I program.

**Table 1. Cancellations, Total Programs, and Cancellation Rate
by Military Department and Joint Programs**

| | No. of Cancellations | No. of Programs | Cancellation Rate |
|--------------|-----------------------------|------------------------|--------------------------|
| Army | 14 | 69 | 20% |
| Navy | 14 | 96 | 15% |
| Air Force | 13 | 68 | 19% |
| Joint | 12 | 45 | 27% |
| Total | 53 | 278 | 19% |

The final SAR for a program that has been cancelled usually identifies (with varying degrees of clarity) who initiated the cancellation. For example: “President Bush ordered the termination of [SRAM II] on 27 Sept. [19]91.”⁹ An example from the “less clear” end of the scale is provided by the Joint Ground Launched Tacit Rainbow. The final SAR for the program states that its funding was not included in the “FY92–FY93 President’s Budget” and that the program was cancelled by the Secretary of Defense.¹⁰ Using such statements from the SARs supplemented by materials found on limited searches on the internet, the initiative for the cancellation for each cancelled program was assigned to the Service, OSD, the White House, or the Congress. In those cases in which the information available left substantial doubt, responsibility for initiating the cancellation was assigned to OSD.

There is a limitation of the attributions made in this way that needs to be noted. A cancellation may actually be initiated by an organization other than the one formally responsible for it.¹¹ There are cases in which, for example, a Service cancels a program because it appears to be highly likely that if it does not do so, OSD or the Congress will—in which case, OSD or the Congress will decide how to reallocate the funding. In other cases the cancellation may result from interactions of some combination of the Military Departments, OSD, the White House, and the Congress. None of these sorts of dynamics was discernible in the information consulted in developing the assignments of responsibility for initiating the cancellation.

Table 2 reports the number of cancellations formally initiated by OSD, the White House, and the Congress. Nothing in this table seems particularly surprising, but it is worth noting that about 34 percent of cancellations were initiated by the Services.

⁹ Selected Acquisition Report (SAR) for SRAM II, December 31, 1991, 7.

¹⁰ SAR for the BGM-136 Joint Ground Launched (JGL) Tacit Rainbow, December 31, 1990, 4.

¹¹ MDAP cancellations are visible in the DoD Budget proposed to the Congress by the President, and in that sense all cancellations are made on the authority of the President.

Table 2. Number and Proportion of Cancellations Initiated by Different Levels of Government

| | No. of Cancellations | Proportion of Cancellations |
|----------------------|-----------------------------|------------------------------------|
| Military Departments | 18 | 34% |
| OSD | 23 | 43% |
| White House | 4 | 7% |
| Congress | 8 | 15% |
| Total | 53 | 100%^a |

^a Adds to less than 100 percent due to rounding.

The definition of “cancellation” used in this paper ensures that all cancelled programs were in SDD or in the early stages of LRIP. In fact, all but eight were in SDD and only one, the C-27J, was in Full Rate Production. Moreover, the average time from MS II/B to cancellation was 5.2 years, and half of all cancellations occurred when the program was no more than 4.3 years beyond MS II/B, as shown in Figure 1. However, the distribution has a fairly long tail. One program was cancelled over eighteen years after it passed MS II and two others were cancelled after more than twelve years.

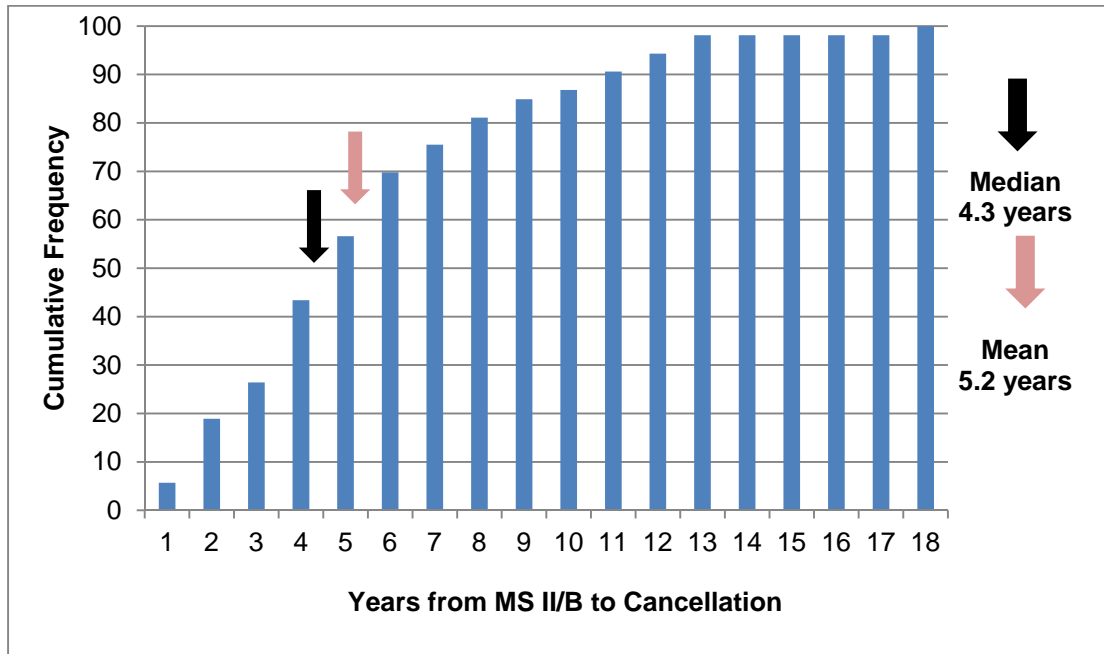


Figure 1. Cumulative Distribution of Time between MS II/B and Cancellation

It would be desirable to distinguish between MDAPs that were cancelled because the program failed in some way and programs that were cancelled because external circumstances changed. Changes in the threat, for example, or large unanticipated reductions in funding, or emergence of new technologies, are situations in which

cancellation of some programs may be the best course of action. Section D identifies a few instances of programs that probably were in large part cancelled because of changes in the threat. Unfortunately, the resources available for this paper did not permit an attempt to classify all cancellations along these lines.

3. Truncations

Severely truncating the number of a system procured is likely to have much the same consequence as cancellation of the program. Accordingly, it is reasonable to extend the census to truncations.

The database used in this paper (and found on the included CD) contains the MS II/B total acquisition quantity (AQ) and the quantity actually acquired or, for programs still underway, the planned quantity for all of the seventy-one programs that passed MS II/B as ACAT I programs during FY 1989–FY 2007. Figure 2 is a histogram of the percentage of the respective MS II/B AQs acquired by these seventy-one MDAPs. Resource limitations precluded extracting from the SARs the corresponding data for programs from FY 1970–FY 1988.

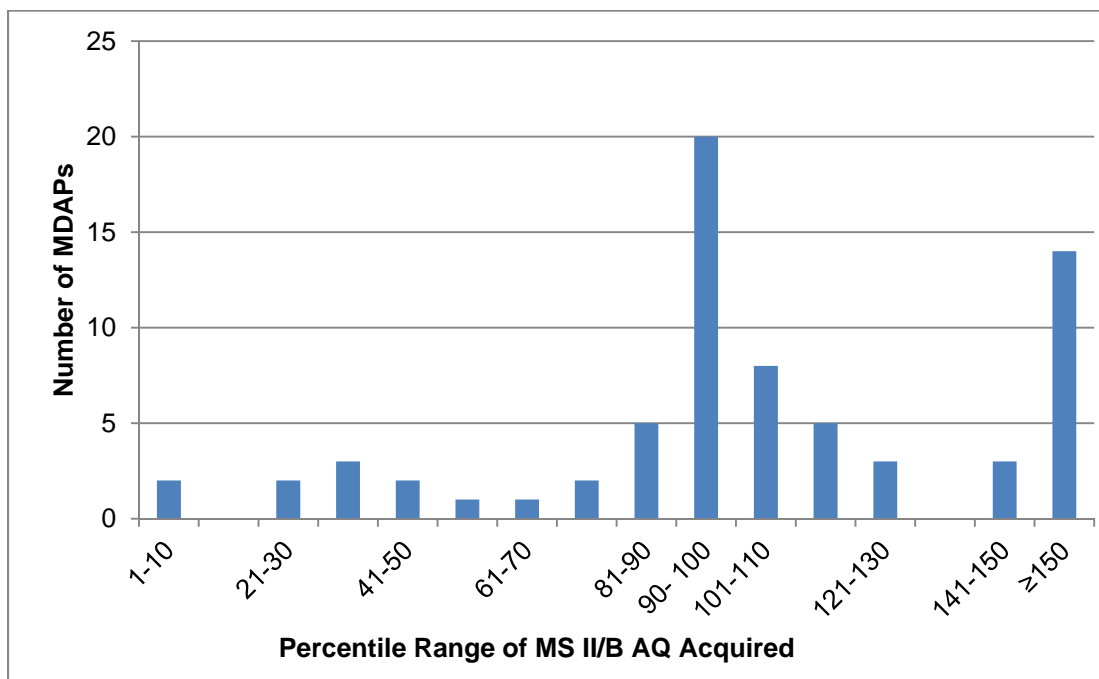


Figure 2. Histogram of the Percentage of the MS II/B AQ Acquired by MDAPs that Passed MS II/B as ACAT I Programs, FY 1989–FY 2007

About three-quarters of the MDAPs that passed MS II/B in the period FY 1989–FY 2007 acquired at least 90 percent of their MS II/B AQ. The median program acquired

100 percent and the average program acquired 111 percent.¹² These figures are somewhat higher than is commonly appreciated and serve to limit the extent to which truncations reasonably can be viewed as a major problem. If the experience of MDAPs that passed MS II/B during FY 1989–FY 2007 is representative, the great majority of MDAPs that were not cancelled eventually acquired most of their MS II/B AQ.

Eighteen of the seventy-one MDAPs, however, acquired less than 90 percent of their AQs, and nine acquired less than half. These programs and the percent of their respective AQs acquired are listed in Table 3. ATIRCM (second entry in the left column of the table) would fit comfortably on the list of cancelled programs. The same cannot be said without a more detailed examination of any of the other seventeen programs that acquired less than 90 percent of their MS II/B AQ, and at least one (the F/A-18E/F) is generally regarded as a model program.

Table 3. MDAPs that Passed MS II/B as ACAT I Programs FY 1989–FY 2007 that Procured at Most 90% of their MS II/B AQ as of the December 31, 2012 SAR

| MDAP | MS II/B | % MS II/B AQ | MDAP | MS II/B | % MS II/B AQ |
|-------------------|---------|--------------|---------------------------|---------|--------------|
| Excalibur | 1997 | 10 | F/A-18E/F | 1992 | 55 |
| ATIRCM | 1995 | 10 | B-1B CMUP | 1995 | 65 |
| F-22 | 1991 | 29 | SBIRS High | 1997 | 80 |
| DDG-1000 | 2006 | 30 | AEHF Satellite | 2001 | 80 |
| AIM-9X Sidewinder | 1996 | 31 | JTRS HMS | 2004 | 82 |
| FGM-148A Javelin | 1989 | 36 | SMART-T | 1992 | 83 |
| JSOW | 1992 | 38 | AGM-158 JASSM AAWS-M | 1998 | 83 |
| C-5 RERP | 2001 | 41 | EELV (Atlas V & Delta IV) | 1998 | 84 |
| HIMARS | 1999 | 43 | AFATDS | 1989 | 87 |

Because of this uncertainty, the analysis presented in the following sections is concerned only with cancellations. This decision was reinforced by another consideration. A program may be truncated for the same set of reasons that cause cancellations—shortcomings of the program, threat changes, funding reductions, and emergence of new technologies. In addition, a truncation can be caused by a force structure change. A careful development of the AQ for a program involves a range of distinct considerations—the size of the force to be equipped with the system, the reliability of the system, policies on depot maintenance and sparing, war reserve stocks,

¹² This number excludes the observations for four programs, each of which apparently bought more than 500 percent of its MS II/B AQ. These figures are so high that they call into question the realism of what is reported in the SAR as the MS II/B AQ.

and basing. A change in any of these could produce a reduction in the number of a system needed.

C. Cost Growth and Cancellations

It seems to be the conventional wisdom that cost growth is a major cause of most program cancellations. There are some well-known instances in which this was the case. The literature, however, does not establish that it is a typical cause of program cancellations. That is a point that needs to be checked and at least to some extent can be.

Following McN-W (2014), this paper uses Program Acquisition Unit Cost (PAUC) as its measure of cost. Cost growth is computed by comparing the PAUC of the MS II/B baseline with the PAUC reported in a later SAR, normalized to the MS II/B baseline AQ. The PAUC from the later SAR (in the same base year dollars as the MS II/B PAUC) is the actual cost or, for ongoing programs, an estimate based on significant actual cost experience.

There is a problem with computing cost growth for a program that has been cancelled: the final SAR rarely reports the data required to compute quantity adjusted PAUC growth.¹³ It is, however, possible to get some sense of the amount of cost growth that occurred prior to cancellation by going back to the most recent SAR that reported the estimated costs for developing the system and procuring some quantity of it. Proceeding in this way, we were able to estimate cost growth for twenty-five of the fifty-three MDAPs that were cancelled. The computations are documented in the third Excel file on the included CD. The SARs did not report the data needed to estimate PAUC growth for the other twenty-eight cancelled programs.

The PAUC growth estimates probably understate the true PAUC growth, for two reasons. First, they do not capture the cost growth between the date of the SAR used and the termination of the program. Second, there tends to be some delay in reporting cost that can be expected to occur based on the evidence to date but which has not yet in fact materialized. This might be especially the case for programs that were cancelled.

Table 4 presents a comparison of PAUC growth data for the 151 MDAPs used in McN-W (2014) (none of which was cancelled) and PAUC growth for twenty-five MDAPs that were cancelled. The average PAUC growth and the proportion of the sample with a PAUC growth of at least 50 percent are both higher for programs that were cancelled, although neither difference is statistically significant using conventional

¹³ It reports the Research, Development, Test and Evaluation and any Procurement funding that will actually have been expended when the program is over. Usually these expenditures do not result in the production of any fully configured end items, and the SAR does not report what it would cost to complete the development program and procure some quantity of the system.

statistical tests and a significance level of 5 percent.¹⁴ The proportion of cancelled MDAPs that (pre-cancellation) had a negative PAUC growth is very slightly above that for programs that were not cancelled, but again the difference is not statistically significant.¹⁵ In short, based on the twenty-five programs examined, programs that were cancelled did have higher cost growth on average than programs that were not cancelled, but not greatly higher, and fourteen of the twenty-five programs would not even have had a significant Nunn-McCurdy breach after normalizing for quantity.

Table 4. Characteristics of Quantity Normalized PAUC Growth, Samples of Not Cancelled and Cancelled MDAPs

| | Not Cancelled | Cancelled |
|-----------------------------|----------------------|------------------|
| Average PAUC Growth | 32% (151) | 42% (25) |
| Distribution of PAUC Growth | | |
| ≥ 50% | 26% (40) | 40% (10) |
| ≥30% but < 50% | 11% (17) | 0% (0) |
| 0 to <30% | 46% (64) | 40% (10) |
| < 0 | 19% (30) | 20% (5) |

Note: Numbers in parentheses are the number of MDAPs.

Fifty of the 176 MDAPs for which we have a PAUC growth estimate showed growth of at least 50 percent. (See the third row of Table 4.) Of these, ten were cancelled and forty were not. The sample cancellation rate for programs with PAUC growth of at least 50 percent is therefore 20 percent. The cancellation rate for programs with cost growth of less than 50 percent is much less—about 12 percent. The key point for present purposes, however, is that 80 percent of the MDAPs with cost estimates of at least 50 percent were *not* cancelled. In short, there is more than cost growth influencing MDAP cancellations.¹⁶

¹⁴ A t-test indicates there is no statistical difference between the mean PAUC growth rates for cancelled and non-cancelled programs. Two-sample tests of proportions indicate there is no statistical difference in the proportion of programs at certain PAUC growth rate thresholds (≥ 50 percent, ≤ 30 percent, and < 0) between the sample of cancelled and non-cancelled programs.

¹⁵ It is also worth noting that PAUC growth for programs that were cancelled shows the same pattern with respect to funding climate as does average PAUC growth of programs that were not cancelled. That is, MDAPs that passed MS II/B during bust phases of the boom-bust cycle had higher average PAUC growth, a greater portion with PAUC growth of at least 50 percent, and a smaller portion with a negative PAUC growth. These statements for the cancelled programs can be verified using the third Excel workbook referred to above.

¹⁶ Given the estimates in Table 7, the maximum number of programs cancelled that had cost growth of at least 50 percent is 38, which would imply that just over 50 percent of programs with cost growth of at least 50 percent were not cancelled.

D. Plan of the Analysis

Those in the defense community are likely to reach for “other factors” relevant to cancellation in either of two boxes. One of these is acquisition policy and process, which is presumed to influence MDAPs in ways important to their success or lack thereof—for example, contract type, maturity of key technologies to be used, realism of the cost estimate, and the degree of concurrence between SDD and production, among others. Within this context, the relevant measure is cancellation rates for cohorts of MDAPs that passed MS II/B during different periods. We wish to know whether cohort cancellation rates were significantly higher or lower under some of these regimes than others.

The other box is changes in funding. When DoD funding declines substantially, the Department must make cuts in programs and it would be no surprise to find that includes cancellation of some MDAPs. In this context, the relevant measure is cancellations organized by the year in which they occur, regardless of when the cancelled programs passed MS II/B.

To use these points as the frame for an analysis, it is necessary to specify acquisition regimes and funding climates. This paper distinguishes five successive DoD acquisition regimes:¹⁷

1. Defense Systems Acquisition Review Council (DSARC), 1970–1982
2. Post-Carlucci Initiatives DSARC, 1983–1989¹⁸
3. Defense Acquisition Board (DAB), 1990–1993
4. Acquisition Reform (AR), 1994–2000
5. DAB post AR, 2001–2012

For reasons that are brought out below, the cohort cancellation rate requires a different specification of breakpoints between funding climates than does the annual cancellation rate. In broad terms, however, there were two complete boom-bust cycles during the period 1970–2008:

- The reduction in DoD funding associated with the winding down of US involvement in the War in Vietnam through the end of the Carter-Reagan buildup, roughly 1970–1986.

¹⁷ The main reference we have used is J. Ronald Fox, *Defense Acquisition Reform, 1960 to 2009: An Elusive Goal* (Washington, DC: US Army Center of Military History, 2011). Fox identifies the key features of the first four of these periods.

¹⁸ After then-Deputy Secretary of Defense Frank Carlucci. There is some uncertainty about when the Post-Carlucci Reforms DSARC should end and the DAB regime should begin. The relevant statutes were passed in 1986, and the DAB began functioning under that name in late FY 1987 or early FY 1988; however, DoD did not implement the full set of reforms required by statute until 1990. We have for that reason set the line at 1990.

- The post-Cold War reduction in DoD funding and the subsequent 9-11 buildup, roughly 1987–2008.

The start of the withdrawal of US forces from Iraq in 2009 marked the start of a third cycle, which was ratified by passage of the Budget Control Act (BCA) in 2011.

Changes over time in acquisition regime and the boom-bust cycle in DoD funding provide natural experiments that may shed some light on the effects of acquisition policy and funding climate on cancellation rates. For example, each of the five acquisition regimes was in place during a bust phase in the cycle. By looking at changes in the cohort cancellation rate from one acquisition regime to the next during these periods, we may be able to see effects of changes in acquisition policy or process. Similarly, three of the acquisition regimes were in effect during both a bust phase and a boom climate, and so may provide some insight into the effect of a change in funding climate given acquisition regime.

An analysis of natural experiments can be useful, but it is necessary to recognize, that such experiments tend to be poorly controlled. That is, in addition to the easily identified elements of the natural experimental design, there are other factors that may have influenced cohort cancellation rates. We first focus on acquisition regime and funding climate and then, after statistical results for the basic natural experiments are stated, ask whether they are compromised by the omission of other factors.

The following section examines whether there are statistically significant associations between cohort cancellation rates and acquisition regime and funding climate. Section F presents a parallel analysis of annual cancellation rates.

E. Analysis of Cohort Cancellation Rates

Funding and programmatic decisions embedded in the MS II/B baselines of MDAPs are made at least one or two years before the President's Budgets in question are submitted to the Congress. Consequently, those decisions necessarily reflect expectations held by decision makers about the future DoD budget climate, and the breakpoints between different budget climates should mark the points at which there were major shifts in expectations. We used three events to identify the breakpoints between funding climates: (1) the invasion of Afghanistan by the USSR in late December 1979; (2) passage of the Gramm-Rudman-Hollings (GRH) Act in December 1985; and (3) the terrorist attack on the United States on September 11, 2001. Analysis of surrounding presidential statements and budgetary events led to the following breakpoints between the funding climates:

- FY 1981 as the first year of the Carter-Reagan buildup,
- FY 1986 as the final year of the Carter-Reagan buildup, and

- FY 2003 as the first year of the post-9/11 defense buildup.

The funding climates will be referred to as Relatively Constrained (or bust) and Relatively Accommodating (or boom). Senior decision makers could reasonably expect each of the events identified to signal major and sustained changes in the defense funding climate, which in fact they did.

1. Statistical Analysis

Table 5 provides the data on cohort size, number of cancellations, and cohort cancellation rates arrayed by acquisition regime and funding climate. Note that two of the regimes (DAB and AR) operated only in bust climates, so we have only three natural experiments on the effect of a change in funding climate for a given acquisition regime.

Table 5. Average Cancellation Rates for Cohorts, by Acquisition Regime and Funding Climate

| Acquisition Regime | Relatively Constrained | | Relatively Accommodating | |
|---------------------|------------------------|-------------------|--------------------------|-------------------|
| | Period | Cancellation Rate | Period | Cancellation Rate |
| DSARC | 1970–1980 | 14% (10 of 74) | 1981–1982 | 24% (4 of 17) |
| Post-Carlucci DSARC | 1987–1989 | 42% (11 of 26) | 1983–1986 | 12% (6 of 51) |
| DAB | 1990–1993 | 7% (1 of 15) | | |
| AR | 1994–2000 | 14% (6 of 43) | | |
| DAB post AR | 2001–2002 | 27% (4 of 15) | 2003–2007 | 30% (11 of 37) |

Note: Number of cancellations and cohort size in parentheses.

The one feature of Table 5 that stands out is the much higher average cohort cancellation rate in the bust climate (42 percent) than in the boom years (12 percent) for the Post-Carlucci DSARC. A standard test (the t-test) found this difference to be statistically significant. The differences for the other two budget climate experiments were not statistically significant. Two more comprehensive tests produced these same results.¹⁹

¹⁹ The first of these was a logit regression using the DSARC as the reference acquisition regime. Dummy variables marked the other acquisition regimes and slope dummies were used to capture the effect of the different funding climates. We also applied Fisher's exact test to a contingency table for each of the two climates, which rejected the null hypothesis that cohort cancellation rates are independent of the acquisition regime in the bust climate. Inspection of the data strongly suggests that this result is due to the very high average cohort cancellation rate for FY 1987–FY 1989. McN-W (2014) used Analysis of

The statistical analysis did not find any significant association between acquisition regimes and the average cohort cancellation rate within the boom budget climate, but the Post-Carlucci DSARC was significantly higher than the others in the bust climate.

2. Discussion

We start with the question of whether it is historically plausible to attribute the higher average cancellation rate of MDAPs that passed MS II during the latter years of the Post-Carlucci DSARC (FY 1987–FY 1989) to a deterioration of the funding climate.

The backdrop to this question is the lower cancellation rate of programs that passed MS II during FY 1983–FY 1986. This result is intelligible in terms of the changes made by the Carlucci Initiatives, which were, among other things, intended to tighten up the DSARC process and to help ensure that DoD did not start more programs than reasonably anticipated funding would support. In particular, major system new starts became a joint responsibility of the Planning, Programming, and Budgeting System (PPBS) and the acquisition process. The vehicle used was a Major Systems New Starts issue paper developed during the summer Program Review. At least by intent, the new process would favor a relatively low cohort cancellation rate.

This was achieved during the boom years FY 1983–FY 1986, but the cancellation rate for the cohort from the following bust years (FY 1987–FY 1989) was three and one-half times as high—42 percent versus 12 percent. There is, however, good reason to doubt that all of the cancellations were largely due to funding decreases.

The FY 1987–FY 1989 period came just before the end of the Cold War.²⁰ Some of the MDAPs that passed MS II during these years were later cancelled because, in the light of altered perceptions of the threats, they no longer seemed to be of enough utility to justify their cost. While the SARs do not spell out the fact, there is little doubt that changes in the threat were a major factor in the cancellations of SRAM II, the Small ICBM, Peacekeeper Rail Garrison, and possibly some other programs from this cohort. To some extent, then, the high cancellation rate of the FY 1987–FY 1989 cohort is attributable to the end of the Cold War rather than to the prevailing acquisition regime and funding climate.

Variance. (ANOVA); the statistical analysis of average cancellation rates reported in Section F below also does. ANOVA is not used in this section because it is not suited to analysis of categorical data (such as cancellations). ANOVA could be used to analyze variations in the cancellation rates of annual cohorts if the number of programs that pass MS II/B each year is sufficiently large, but we judged it not to be.

²⁰ The Berlin Wall fell on November 9, 1989, just over one month into FY 1990. The Soviet Union was formally dissolved in April 1991.

The high cancellation rate for the FY 1987–FY 1989 cohort also may in part be attributable to a tacit change in the Administration’s policy on new starts. The amount appropriated for DoD acquisition fell by about 30 percent from FY 1986 to FY 1989, and with the passage of GRH and developments in Eastern Europe there was no reason to expect an increase over the then foreseeable future. In the years FY 1987–FY 1989, however, on average 8.3 programs passed MS II annually. This rate was well above the rate for periods of Relatively Constrained funding (6.7/yr. for FY 1979–FY 1980, and 4/yr. for FY 1990–FY 1993). The relatively high new start rates suggest a decreased emphasis on the Carlucci Initiatives goal of not starting more MDAPs than likely future budgets could sustain. In fact, nine of the eleven cancellations from the new starts in the FY 1987–FY 1989 cohort occurred during FY 1990–FY 1993.

The summary conclusion reached depends on the weight given to the historical considerations. If these are discounted, in one of the three relevant natural experiments—but not the other two—a Relatively Constrained funding climate was significantly associated with a higher average cohort cancellation rate. If, instead, the historical factors are heavily weighted, the conclusion would be that neither acquisition regime nor funding climate mattered for cohort cancellation rates. The difference between these two positions is thin. A reasonable conclusion, and the one we suggest, is that the analysis shows that neither acquisition policy and process changes nor changes in funding climate have had much, if any, effect on cohort cancellation rates.

Embedded in this discussion is a question that has not been raised explicitly so far: Are cohort cancellation rates significantly influenced by events that occur after MS II/B, especially changes in budget climate? The analysis of Table 5 implicitly rules out such effects by attributing a cohort cancellation rate only to the budget climate and acquisition regime in effect when a program passed MS II/B. The next subsection examines annual cancellation rates, without regard to when the cancelled programs passed MS II/B. Not surprisingly, cancellations prove to be concentrated in periods of declining funding. In the remainder of this subsection we consider whether these cancellations or a relative absence of cancellations were concentrated in a way that casts “shadows” back on particular MS II/B cohorts. The underlying issue is whether such shadows may have masked effects on cohort cancellation rates of changes in acquisition regime or budget climate.

Shadow effects presumably would be most likely to appear in cohorts that passed MS II/B during the few years before the start of a boom or the start of a bust. There are four such periods during FY 1970–FY 2007. Somewhat arbitrarily using periods of five years duration, these are:

- Before booms: FY 1976–FY 1980 and FY 1998–FY 2002
- Before busts: FY 1982–FY 1986 and FY 2003–FY 2007

If future funding climates do cast shadows, we would expect the programs that passed MS II/B in the years before a boom began to have a relatively low cancellation rate and those that passed MS II/B before a bust began to have a relatively high cancellation rate.²¹ These expectations were not met in the 1970s and 1980s pre-boom and pre-bust periods. They were, however, met in FY 1998–FY 2002, which had a below average cancellation rate (16 percent) and FY 2003–FY 2007, which had an above average cohort cancellation rate of 30 percent.

FY 1998–FY 2000 is at the end of the AR regime and FY 2001–FY 2002 is at the start of the DAB post AR regime. This fact—that the relevant time period crosses acquisition regimes—complicates the problem. Furthermore, adjustment of the average cancellation rate for the FY 1998–FY 2002 cohort would require identifying programs that might have been cancelled except for the good fortune of entering SDD in the years before a boom in funding. There is no plausible way to do this.²² It is possible within the limits of this study to do only a little better on the FY 2003–FY 2007 cohort. Of the eleven programs of this cohort cancelled, seven were cancelled during FY 2009–FY 2012.²³ These had on average spent about 56 months in SDD. Some of these programs may have been cancelled largely for budgetary reasons, but considerably more effort would be required to verify that assumption.

With the evidence available, the overall conclusion on the effects of acquisition regime and funding climate on cohort cancellation rates that we offered earlier remains reasonable: neither acquisition policy and process changes nor changes in funding climate have had much, if any, effect on cohort cancellation rates. A more complete and rigorous analysis of the role played by future funding climates would be desirable, however.

²¹ It might, instead, be that the programs started in times of lean funding tended to be on average of a higher priority and therefore less likely to be cancelled. In fact, the average cancellation rate for programs that passed MS II/B in bust periods (18.3 percent) is slightly less than that of programs that passed MS II/B in boom periods (20.2 percent).

²² We perhaps can see a budget effect in the durations of programs from the FY 1998–FY 2002 cohort that eventually were cancelled. One of the five programs in this cohort to be cancelled (the RAH-66) was cancelled in FY 2000. The other four were cancelled in FY 2010 or FY 2011. By this point, the four programs cancelled had been in SDD for an average of nearly 10 years, more than twice the average duration of programs that were cancelled. (See Figure 1 on page 6.)

²³ Future Combat Systems (FCS), Patriot/MEADS Combined Aggregate Program (CAP), Transformational Satellite Communications System (TSAT), Armed Reconnaissance Helicopter (ARH), Joint Land Attack Cruise Missile Defense Elevated Netted Sensor System (JLENS), VH-71, and C-27J.

F. Analysis of Annual Cancellation Rates

This section presents an analysis of annual cancellation rates. The institutional context for analysis of annual cancellation rates is the program/budget process. Officials from OSD and Service acquisition organizations are involved in the program/budget process but do not administer it. It is not uncommon—and in fact probably is typical—for cancellations to be initiated in the programming or budgeting process of a Service or in the OSD-level programming and budgeting processes.

1. Statistical Analysis

The acquisition regimes relevant to this section are the same as those used in the previous section. The breakpoints between the funding climates need to be changed, however. As was noted above, funding decisions (and decisions contingent on funding) at MS II/B must be made on the basis of expectations because the actual DoD funding levels are not yet known when the decisions are made. In contrast, budget-driven cancellation decisions are not likely to be made until the need for doing so becomes clear. Consequently, they generally will reflect the most recently enacted budget or the upcoming President's Budget. The breakpoints used reflect the actual amounts of Budget Authority for Procurement (in constant dollars) appropriated by the Congress in the relevant fiscal years. Because the breakpoints are not the same as those of the budget climates used in the preceding section, those initially used in this section will be labeled Decreasing Funding and Increasing Funding.

Table 6 presents average cancellation rates organized by funding climate (columns) and acquisition regime (rows). As in the previous section, for a given funding climate, we can examine whether major changes in acquisition policy and process are associated with statistically significant differences in cancellations. We also can look at the effect of bust versus boom in cancellations for a given acquisition policy and process regime.

Table 6. Average Number of Cancellations per Fiscal Year by Acquisition Regime and Funding Climate

| Acquisition Regime | Decreasing Funding | | Increasing Funding | |
|---------------------|--------------------|---------------------------|--------------------|---------------------------|
| | Period | Cancellation Rate | Period | Cancellation Rate |
| DSARC | 1970–1975 | 0.3/yr. (2 in 6 yrs.) | 1976–1982 | 0.6/yr. (4 in 7 yrs.) |
| Post-Carlucci DSARC | 1986–1989 | 2.3/yr. (9 in 4 yrs.) | 1983–1985 | 0.3/yr. (1 in 3 yrs.) |
| DAB | 1990–1993 | 3.3/yr. (13 in 4 yrs.) | | |
| AR | 1994–1998 | 0.4/yr. (2 in 5 yrs.) | 1999–2000 | 0.5/yr. (1 in 2 yrs.) |
| DAB post AR | 2009–2012 | 2.8/yr. (11 in 4 yrs.) | 2001–2008 | 1.3/yr. (10 in 8 yrs.) |

Note: Number of cancellations in parentheses.

The statistical analysis divides the acquisition regimes into two groups:²⁴

- **Post-Carlucci DSARC, DAB, and DAB post AR.** In neither funding climate are these regimes significantly different from each other. The DAB regime operated only in a bust climate. The other two had a significantly higher average cancellation rate in the Decreasing Funding climate than in the Increasing Funding climate. For this group, acquisition regime had no significant effect on the average number of MDAPs cancelled each year, but the cancellation rates were much higher in periods of Decreasing Funding.
- **DSARC and AR.** These regimes also do not differ significantly from each other but have comparatively low cancellation rates in each funding climate. Neither acquisition regime nor funding climate matters significantly in these cases.

Within each of these groups, the average number of programs cancelled per year (for a given funding climate) is similar,²⁵ but only in the first group do we see a marked difference in cancellation rates between the two funding climates. This feature of the

²⁴ Statistical results discussed are based on three separate tests: Analysis of Variance (ANOVA), Tukey-Kramer, and t-tests. ANOVA is used to determine whether there is a statistical difference in the mean number of cancellations across the different acquisition regimes within each funding climate. The null hypothesis (no statistical difference in means across regimes) is only rejected for the decreasing funding climate. A Tukey-Kramer test is then used to perform pair-wise comparisons and identify which specific regimes are statistically different from one another during the decreasing funding climate. T-tests test the difference in each acquisition regime's cancellation rate across the two funding climates.

²⁵ A t-test indicates that pooled annual cancellation rates are statistically different across the decreasing and increasing funding climates (p-value = .063). When regime-specific t-tests are performed, the Post-Carlucci DSARC and DAB post AR are the only regimes found to have cancellation rates that differ statistically across funding climates.

results suggests that one or more factors not yet identified affect the outcome of our natural experiments.

2. Discussion

Figure 3 shows the number of cancellations in each fiscal year. Two distinct clusters of cancellations are evident in this figure: FY 1986–FY 1992 and FY 2009–FY 2012. These were both periods of steep decline in procurement funding.

FY 1986–FY 1993 was the bust phase following the Carter-Reagan boom in defense budgets. In December 1985, President Reagan signed into law the GRH. Like the BCA adopted some twenty-five years later, GRH set binding budget limits and imposed sequestration on appropriations in excess of those limits. From peak procurement Budget Authority of \$177.9 billion in FY 1985, procurement fell to \$76.5 billion in FY 1993, 43 percent of its FY 1985 level.²⁶ Twenty-two MDAPs were cancelled during FY 1986–FY 1993.

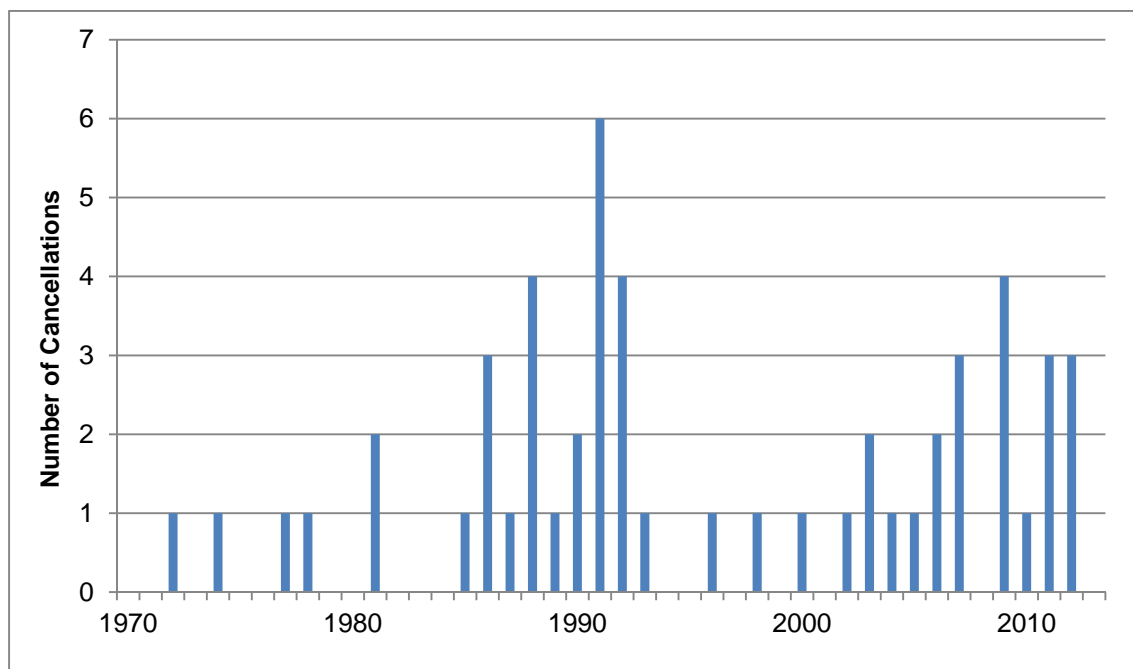


Figure 3. Number of MDAPs Cancelled Each Year, 1970–2012

The second period of declining funding was FY 2009–FY 2012. The financial crisis occurred towards the end of Calendar Year (CY) 2008, or approximately during the first quarter of FY 2009. The withdrawal of US troops from Iraq began in July of 2009 and the

²⁶ These data, as well as similar funding data cited later, are in billions of constant FY 2014 dollars of budget authority. They are from Table 6-8 (p. 142ff) of the Office of the Under Secretary of Defense (Comptroller), *National Defense Budget Estimates for FY 2014*.

BCA was signed into law late in FY 2011. FY 2012 DoD procurement funding constant dollars stood at about two-thirds of its FY 2008 level. Eleven MDAPs were cancelled during FY 2009–FY 2012. Thirty-three MDAPs—over 60 percent of the total—were cancelled during the twelve years of these two periods taken together, an average of nearly three cancellations each year. During the other thirty-one years on average about two MDAPS were cancelled every three years (for a total of 20).

The absence of a cluster of cancellations during the early to mid-1970s is particularly surprising because this apparently was the bust phase of a boom-bust cycle associated with US involvement in the War in Vietnam. Procurement funding during the Vietnam War in constant dollars averaged about 20 percent above its prewar level. Withdrawal of US forces from Vietnam began in 1969. Virtually all US forces had been withdrawn by the end of 1972, but US material support for South Vietnam continued into 1975. In FY 1969, procurement funding in constant dollars was \$116.8 billion. Real procurement funding was down by 15.5 percent in FY 1970, and by FY 1975 it was just over half what it had been in 1969. This decline was less than that following the Carter-Reagan defense buildup but greater than the decline of FY 2009–FY 2012.

A likely explanation for the comparatively low cancellation rate during FY 1970–FY 1975 can be found in changes over the relevant period in the composition of procurement funding. A large part of the increase in procurement funding during FY 1962–FY 1969 was for munitions and procurement to replace systems lost in combat, particularly aircraft. These increases were reversed as the US forces were withdrawn and US support of South Vietnam reduced and, in 1975, ended. Insofar as procurement of MDAPs is concerned, there was little or no boom-bust cycle associated with the Vietnam War.²⁷ Except for FY 1970, procurement funding in constant dollars during this period remained below its prewar peak, however.

The period FY 1994–FY 1998 seems to have a similar explanation. Although procurement funding in constant dollars was 17.7 percent lower in FY 1994 than it was in FY 1993, across the four fiscal years FY 1995–FY 1998, funds budgeted for procurement declined only very slightly—from \$62.8 billion to \$60.5 billion. FY 1994–FY 1998 was then a period of comparatively stable procurement funding.

The implication of these comments is that periods of sharply decreasing funding should be treated as a separate funding climate in the analysis of average annual cancellation rates. Following this suggestion, Table 7 displays average annual cancellation rates by acquisition regime and two budget climates—Sharply Decreasing Funding, and Stable or Increasing Funding.

²⁷ These comments are based on an unpublished IDA working database drawn from various US government sources. We are indebted to Dr. Daniel Cuda for providing these data.

Statistical analysis of the data in Table 7 yields two conclusions. First, the average annual cancellation rate is significantly higher in periods when acquisition funding is Sharply Decreasing than it is in periods of Stable or Increasing funding. Second, while there is no significant association of funding climate and acquisition regime in the Sharply Decreasing funding climate, the average annual cancellation rate under the DAB post AR was significantly higher than it was under the other three regimes for which we have observations in the Stable or Increasing climate.

Table 7. Average Number of Cancellations per Fiscal Year by Acquisition Regime and an Alternative Specification of Funding Climate

| Acquisition Regime | Sharply Decreasing Funding | | Stable or Increasing Funding | |
|---------------------|----------------------------|---------------------------|------------------------------|---------------------------|
| | Period | Cancellation Rate | Period | Cancellation Rate |
| DSARC | | | 1970–1982 | 0.5/yr. (6 in 13 yrs.) |
| Post-Carlucci DSARC | 1986–1989 | 2.3/yr. (9 in 4 yrs.) | 1983–1985 | 0.3/yr. (1 in 3 yrs.) |
| DAB | 1990–1993 | 3.3/yr. (13 in 4 yrs.) | | |
| AR | | | 1994–2000 | 0.4/yr. (3 in 7 yrs.) |
| DAB post AR | 2009–2012 | 2.8/yr. (11 in 4 yrs.) | 2001–2008 | 1.3/yr. (10 in 8 yrs.) |

Note: Number of cancellations in parentheses.

We found no strong reason in the record of changes in acquisition policy or process or in the Program/Budget process that accounts for the significantly higher cancellation rate for the DAB post AR during FY 2001–FY 2007. Inspection of the list of cancelled programs indicates that four of the ten cancellations were initiated by the Defense Acquisition Executive (DAE) (that is, the Under Secretary of Defense for Acquisition, Technology and Logistics (USD(AT&L))) or a Service Acquisition Executive (SAE), where in the previous fifteen years the SARs attributed only two cancellations (out of twenty-five) to the DAE (and none to an SAE). Moreover, some or all of the four cancellations that were attributed by the SARs to a Service Secretary may have been initiated by the SAE. This tends to confirm that the higher cancellation rate of FY 2001–FY 2007 is to a significant extent attributable to the DAB post AR.

In comparison to AR, the DAB post AR exercised more active oversight of MDAPs. It also seems clear that changes initiated by DoD and statutory changes have increased the authority of the USD(AT&L). The mystery is why the DAE and SAEs would have acted during the boom years FY 2003–FY 2007 to cancel a comparatively large number of programs. It is relevant in this regard to recall from the preceding section that about 30

percent of the cohort of programs that passed MS B during FY 2003–FY 2007 was eventually cancelled. Thus, while the DAB post AR of FY 2003–FY 2007 may have been exceptionally active in cancelling programs that passed MS II/B in earlier years, it did not prove to be exceptionally able to limit the number of new starts to what future budgets could accommodate.

G. Conclusions

McN-W (2014)’s pivotal conclusion about PAUC growth was simple: There was no statistically significant association between changes over time in acquisition policy and process and PAUC growth, but there was a strong association between the budget climate prevailing when a program passed MS II/B and PAUC growth. The conclusions offered here are broadly similar but more complicated; they include both generalities and exceptions to the generalities, and these may be equally important.²⁸

Average cohort cancellation rates are not strongly influenced by either acquisition regime or funding climate. The exceptions to this rule are provided by the Post-Carlucci DSARC, which had a:

- Significantly higher cohort cancellation rate than the other acquisition regimes in the bust period FY 1987–FY 1989; and a
- Significantly higher average cohort cancellation rate in the bust period than in the boom period.

This exception deserves further exploration as it may provide an excellent illustration of a mechanism that could help limit the number of new starts to what likely future budgets will support.

In contrast, annual cancellation rates, although not strongly influenced by acquisition regime, are strongly associated with funding climate. A possible exception to the first part of this rule is provided by the DAB post AR, which had a significantly higher average annual cancellation rate than other acquisition regimes during periods of Stable or Increasing funding. There were no exceptions to the second part of the rule. The complications and uncertainties involved with the conclusions on the effects of changes in acquisition regimes should not be allowed to obscure this point. Sharp cuts in DoD funding are associated with high annual cancellation rates: about 60 percent of all cancellations took place in two periods of large cuts in acquisition funding.

²⁸ McN-W (2014) presented evidence indicating that the funding climates that a program passes through after MS II/B seem to have comparatively little influence on PAUC growth. The analogous condition evidentially does not hold for cancellations, and it is basically for that reason that the analysis of cancellation is more complicated than the analysis of PAUC growth.

Although at first glance it might seem that these two conclusions together absolve the MS II/B process from responsibility for cancellations, they do not. It is important to distinguish three categories of cancellations. First, some programs are cancelled because the threat or technology has changed. Cancellations legitimately in this category typically should be viewed as an appropriate response to altered circumstance. Second, some of the programs cancelled at times when funding for acquisition was sharply contracting have shown signs of failing—badly slipped schedules, high cost growth, and continued technical difficulties. These failures probably can be counted as failures of the acquisition process even though budgetary considerations dictated the timing of the cancellations. Third, some programs cancelled should not have been started when they were because they could not be sustained at the future funding levels that then could be reasonably expected. This paper suggests that responsibility for this third category of cancellations rests with the means, or lack of effective means, for relating DoD's acquisition process and the resource allocation process.²⁹

The conclusions offered by this paper primarily are useful because they direct attention to changes in funding levels and the resource allocation process whose centrality has not been recognized in discussions of acquisition reform. Attention typically has focused on acquisition policy and process. While changes in acquisition policy and process are quite possibly justified on other grounds, the many that have been made over the past 45 years seem to have influenced cancellations, at most, episodically. In contrast, changes in funding climate are strongly associated with cancellations, but the role of the resource allocation process has received limited attention in discussions of acquisition reform. It arguably is crucial. DoD force structure, the capabilities that the Department was expected to provide, and funding were inconsistent during the 1970s and for more than a decade after the end of the Cold War. That inconsistency, rather than flaws in acquisition policy or process, is the context in which most cancellations arise and presumably is a major factor to be considered in designing proposals for improved outcomes.

²⁹ Examples of each of these categories of cancellations appeared in the discussion: Cancellations of some systems following the end of the Cold War, cancellation of seven of the FY 1987–FY 1989 cohort during FY 1990–FY 1993, the cancellation in FY 2010–FY 2011 of four systems from the FY 1998–FY 2002 cohort that on average had been in SDD nearly 10 years. It would be useful to know more about the characteristics of programs that were cancelled and how they compare to contemporaneous programs that were not cancelled.

Illustrations

Figures

| | |
|--|----|
| Figure 1. Cumulative Distribution of Time between MS II/B and Cancellation..... | 6 |
| Figure 2. Histogram of the Percentage of the MS II/B AQ Acquired by MDAPs that Passed MS II/B as ACAT I Programs, FY 1989–FY 2007 | 7 |
| Figure 3. Number of MDAPs Cancelled Each Year, 1970–2012..... | 19 |

Tables

| | |
|--|----|
| Table 1. Cancellations, Total Programs, and Cancellation Rate by Military Department and Joint Programs | 5 |
| Table 2. Number and Proportion of Cancellations Initiated by Different Levels of Government | 6 |
| Table 3. MDAPs that Passed MS II/B as ACAT I Programs FY 1989–FY 2007 that Procured at Most 90% of their MS II/B AQ as of the December 31, 2012 SAR | 8 |
| Table 4. Characteristics of Quantity Normalized PAUC Growth, Samples of Not Cancelled and Cancelled MDAPs..... | 10 |
| Table 5. Average Cancellation Rates for Cohorts, by Acquisition Regime and Funding Climate..... | 13 |
| Table 6. Average Number of Cancellations per Fiscal Year by Acquisition Regime and Funding Climate | 18 |
| Table 7. Average Number of Cancellations per Fiscal Year by Acquisition Regime and an Alternative Specification of Funding Climate | 21 |

References

- Fox, J. Ronald. *Defense Acquisition Reform, 1969 to 2009: An Elusive Goal*. Washington, DC: U.S. Army, Center for Military History, 2011.
- Jarvaise, Jeanne M., Jeffrey A. Drezner, and Dan Norton. "The Defense System Cost Performance Database: Cost Growth Using Selected Acquisition Reports." RAND Report MR-625-OSD. Santa Monica, CA: The RAND Corporation, 1996.
- McNicol, David L., and Linda Wu. "Evidence on the Effect of DoD Acquisition Policy and Process on Cost Growth Major Defense Acquisition Programs." IDA Paper P-5126. Alexandria, VA: Institute for Defense Analyses, September 2014.
- McNicol, David. "Breakpoint of the Budget Climates." Memorandum to Dr. D. Mark Husband, July 28, 2014 (unpublished).
- Office of the Under Secretary of Defense (Comptroller). *National Defense Budget Estimates for FY 2014*. Washington, DC, 2014.
- Selected Acquisition Report for BGM-136 Joint Ground Launched (JGL) Tacit Rainbow*. December 31, 1990.
- Selected Acquisition Report for SRAM II*. December 31, 1991.

Abbreviations

| | |
|---------|---|
| ACAT | Acquisition Category |
| ANOVA | Analysis of Variance |
| AQ | Acquisition Quantity |
| AR | Acquisition Reform |
| ARH | Armed Reconnaissance Helicopter |
| BCA | Budget Control Act |
| CAP | Combined Aggregate Program |
| CD | Compact Disc |
| CY | Calendar Year |
| DAB | Defense Acquisition Board |
| DAE | Defense Acquisition Executive |
| DoD | Department of Defense |
| DoDI | Department of Defense Instruction |
| DSARC | Defense Systems Acquisition Review Council |
| EMD | Engineering and Manufacturing Development |
| FCS | Future Combat Systems |
| FY | Fiscal Year |
| GRH | Gramm-Rudman-Hollings Act |
| ICBM | Intercontinental Ballistic Missile |
| IDA | Institute for Defense Analyses |
| JGL | Joint Ground Launched |
| JLENS | Joint Land Attack Cruise Missile Defense Elevated Netted Sensor System |
| LRIP | Low Rate Initial Production |
| MDA | Milestone Decision Authority |
| MDAP | Major Defense Acquisition Program |
| MP-RTIP | Multi-Purpose Radar Technology Insertion Program |
| MS | Milestone |
| OSD | Office of the Secretary of Defense |
| PAUC | Program Acquisition Unit Cost |
| PPBS | Planning, Programming, and Budgeting System |

| | |
|-----------|---|
| SAE | Service Acquisition Executive |
| SAR | Selected Acquisition Report |
| SDD | System Design and Development |
| SRAM | Short-Range Attack Missile |
| TSAT | Transformational Satellite Communications System |
| US | United States |
| USD(AT&L) | Under Secretary of Defense for Acquisition, Technology and Logistics |
| USSR | Union of Soviet Socialist Republics |

| | | | | | | |
|---|-------------|-----------------------|---------------------------------------|------------------------------------|---|--|
| REPORT DOCUMENTATION PAGE | | | | | <i>Form Approved OMB No. 0704-0188</i> | |
| <small>The public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing the burden, to Department of Defense, Washington Headquarters Services, Directorate for Information Operations and Reports (0704-0188), 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302. Respondents should be aware that notwithstanding any other provision of law, no person shall be subject to any penalty for failing to comply with a collection of information if it does not display a currently valid OMB control number.</small> | | | | | | |
| PLEASE DO NOT RETURN YOUR FORM TO THE ABOVE ADDRESS. | | | | | | |
| 1. REPORT DATE (DD-MM-YYYY) | | 2. REPORT TYPE | | | 3. DATES COVERED (From - To) | |
| 4. TITLE AND SUBTITLE | | | | 5a. CONTRACT NUMBER | | |
| | | | | 5b. GRANT NUMBER | | |
| | | | | 5c. PROGRAM ELEMENT NUMBER | | |
| 6. AUTHOR(S) | | | | 5d. PROJECT NUMBER | | |
| | | | | 5e. TASK NUMBER | | |
| | | | | 5f. WORK UNIT NUMBER | | |
| 7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) | | | | | 8. PERFORMING ORGANIZATION REPORT NUMBER | |
| 9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES) | | | | | 10. SPONSOR/MONITOR'S ACRONYM(S) | |
| | | | | | 11. SPONSOR/MONITOR'S REPORT NUMBER(S) | |
| 12. DISTRIBUTION/AVAILABILITY STATEMENT | | | | | | |
| 13. SUPPLEMENTARY NOTES | | | | | | |
| 14. ABSTRACT | | | | | | |
| 15. SUBJECT TERMS | | | | | | |
| 16. SECURITY CLASSIFICATION OF: | | | 17. LIMITATION OF ABSTRACT | 18. NUMBER OF PAGES | 19a. NAME OF RESPONSIBLE PERSON | |
| a. REPORT | b. ABSTRACT | c. THIS PAGE | | | 19b. TELEPHONE NUMBER (Include area code) | |

